SMECTITE-SERPENTINE MIXTURES IN THE LAFAYETTE METEORITE

H. G. Changela[1] and J. C. Bridges[1]. [1]Space Research Centre, Dept. of Physics & Astronomy, University of Leicester LE1 7RH, UK. E-mail: hgc3@le.ac.uk

Introduction: The nakhlite meteorites contain Fe-carbonate, phyllosilicate, salts and silicate gel that formed from low temperature fluids near the surface of Mars e.g. [1-3]. We report the results of an HRTEM and EMPA study of the phyllosilicate and gel in the Lafayette meteorite from the base of the nakhlite pile [4] in order to fully characterise these phases and enable comparisons to be made with minerals identified on the surface of Mars.

Methods and Sample: Phyllosilicate and gel were examined in Lafayette sample BM1958, 775 by SEM and EMPA. TEM sections were then prepared from these areas by FIB-SEM and studied with a Jeol 2100 TEM with EDS and SAED, STEM, HRTEM.

Results: Lafayette has three textural types of phyllosilicate. The first type is found along fracture-filled veins in olivine. This has a fibrous habit and is consistent with previous studies [1]. Secondly, phyllosilicate 'rosettes' are found enclosed by Ca-siderite within the veins. They are approximately 1 μm in diameter and are also fibrous, radiating from central cores. HRTEM of one of the rosettes shows its main basal fringes (0.9 nm) sandwiched by smaller fringes (0.7 nm). EPMA of the veining phyllosilicate shows its stoichiometry to be closest to an Fe-smectite. The third textural type of phyllosilicate has replaced patches of feldspathic mesostasis. It occupies approximately 2% of the polished section studied. HRTEM of it shows most of the basal fringes (0.7 nm) to be characteristic of a 1:1 phyllosilicate e.g. serpentine. However, some parts of this mesostasis phyllosilicate have fringes (1.1 nm) representing a 2:1 structure. The stoichiometry of the mesostasis phyllosilicate is most consistent with Fe-serpentine having (Si,Al):(Fe,Mg,Al,Mn) = 2:2.8 and Mg# = 0.38, 8 wt% Al_2O_3 [3], with a berthierine-type composition $(Fe^{2+},Fe^{3+},Mg,Al)_{2-3}(Si,Al)_2(OH)_4$ Zones of amorphous gel are found within the first and third phyllosilicate textures. Its composition is similar to that of the phyllosilicate [3].

Discussion: Formation of serpentine-type minerals with 0.7 nm basal spacing in Lafayette seems to be most associated with alteration of the mesostasis but it is also present within the veins. Its formation in Lafayette may indicate higher temperatures $\leq 150^{o}C$, slower cooling and/or lower Si activity in the hydrothermal fluid at the bottom of the nakhlite pile compared to other nakhlites from nearer the surface which are dominated by the amorphous gel and salts [2,3]. Serpentines have recently been detected on the surface of Mars [5]. The mixture of 1:1 and 2:1 phyllosilicates and gel in Lafayette could be representative of the phyllosilicates on the martian surface with formation under similar conditions. We suggest that impact induced melting of subsurface ice led to the hydrothermal alteration [3].

References: [1] Treiman A. H. et al. 1993. *Meteoritics* 28: 86-97. [2] Bridges J. C. et al. 2001 *Space Science Reviews* 96, 365-392. [3] Changela H. G. and Bridges J. C. 2010. *Meteoritics & Planetary Science* (in rev.). [4] Mikouchi T. et al. 2006. Abstract #1865. 37th Lunar & Planetary Science Conference. [5] Ehlmann B. L. et al. 2009. *Journal of Geophysical Research.* 114: doi:10.1029/2009JE003339.